

DEPARTMENT OF THE INTERIOR,  
BUREAU OF EDUCATION.

ADVANCED EDUCATIONAL WORK WITHIN A GOVERNMENT  
BUREAU.

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During the past 10 years graduate courses of instruction in physics, mathematics, and chemistry have been maintained at the Bureau of Standards<sup>1</sup> in Washington. The work has been carried out upon a semiofficial basis, the object being the better training of the younger members of the staff for their technical duties.

A brief account of this work may be of interest at this time, especially considering the present urgent need of technically trained men. Furthermore, the results of an experiment in maintaining graduate educational work in a Government bureau may be of interest to those who have studied the project of a national university.

*History of the work.*—There is ample legal authority for the maintenance of such educational work within a Government bureau. A joint resolution passed by Congress in 1892 opened the Government collections for research and educational uses. This was broadened by an act in 1901, which stated that:

Facilities for study and research in Government departments \* \* \* shall be afforded to scientific investigators and to duly qualified individuals and students \* \* \* under such rules and restrictions as the heads of departments and bureaus may prescribe.

<sup>1</sup> The Bureau of Standards is housed in an attractive group of buildings located in a fine oak forest in the suburbs of Washington. Its equipment is remarkably complete, and its staff is composed of scientific men of the best type. In its work, surroundings, and personnel the bureau resembles a university far more than a Government establishment of the traditional sort, and its conditions seem to be ideal for the prosecution of the educational work described.

The functions of the bureau are thus enumerated in the Congressional Directory:

The custody of the standards; the comparison of the standards used in scientific investigations, engineering, manufacturing, commerce, and educational institutions, with the standards adopted or recognized by the Government; the construction, when necessary, of standards, their multiples and subdivisions; the testing and calibration of standard measuring apparatus; the solution of problems which arise in connection with standards; the determination of physical constants and properties of materials, when such data are of great importance to scientific or manufacturing interests and are not to be obtained of sufficient accuracy elsewhere; and other investigations as authorized by Congress. The bureau is authorized to exercise its functions for the Government of the United States, for any State or municipal government within the United States, or for any scientific society, educational institution, firm, corporation, or individual within the United States engaged in manufacturing or other pursuits requiring the use of standards or standard-measuring instruments. For all comparisons, calibrations, tests, or investigations, except those performed for the Government of the United States or State governments, a reasonable fee is charged.

The facilities of the bureau were freely utilized during the war for scientific investigations relating to materials for warfare, and the number of its employees was more than doubled. Three hundred soldiers were detailed to assist in the bureau's investigations for the Army. Since the signing of the armistice the number of employees has been materially reduced.—[Editor.]

The work at the Bureau of Standards was started in 1908 by a group of the younger members of the staff who were extremely anxious to continue their academic work. They organized an association for the purpose, the direction of the undertaking being placed in the hands of an elected executive committee of five members. This students' committee planned and organized the work, decided upon the courses to be given, secured instructors, and executed all the necessary details. In this they had the sympathetic support of the Director and the older members of the staff. Five courses were offered the first year, and the work was successful from the start. The general plan of the work as laid out this first year has been followed in the further development, and no radical changes have been made.

The following year a somewhat complicated set of committees was organized for the administration of the work. Committees appointed by the Director performed most of the functions of a university faculty, deciding upon courses, engaging instructors, etc. A committee of the students secured information on courses desired, collected the tuition fees from the students, and performed other similar duties. This arrangement continued for eight years, during which time it became increasingly evident that the arrangement was unnecessarily complicated, and that the real responsibility naturally gravitated to a very few men who took an active interest in the work.

Accordingly, in 1917, the machinery was reduced to a single committee of six members. Four of these are appointed by the Director, and two are elected annually by the student body from among themselves. The committee exercises full control, but the student body is fully consulted and is urged to suggest courses and instructors.

*Scope of work.*—The courses have been along the same general academic lines as those offered in the graduate schools of the better universities. The subjects have been limited to the general field of physics, mathematics, and chemistry, and, measured by the number of courses given, the emphasis has been in this order. Until last year it was not feasible to maintain repeating sequences of courses in as systematic a manner as was desirable, although efforts were made in that direction. The increase in the size of the bureau has, however, provided a larger student body to support the work, and two three-year cycles are now provided, one in physics and one in mathematics. As many additional courses are given as can be supported, but these six are treated as preferred courses, to be given even if the number of students registering for them is smaller than would otherwise be deemed necessary for a course, and even if by so doing the chances of giving other desirable courses are lessened.

This enables men to plan their work in a systematic way, so that it is possible for them in a few years to cover the essentials of the work ordinarily required by the universities for the Ph. D. degree. A man may, within a reasonable time, do sufficient work at the bureau to enable him to secure his doctorate in a single final year of residence work at a university. Written examinations are given regularly at the conclusion of a course, and have had much to do with maintaining a high standard.

Up to the present time slightly more than half of the courses have been given by men not connected with the bureau. Other things being equal, it has been the policy to get men from outside the bureau to give the courses, when suitable men could be secured. Experience has shown that many men who are eminent in their subjects are willing to give such courses of lectures, the real incentive being love of their work and the desire to see it advanced, rather than the nominal financial remuneration which it has been possible to offer them. The following institutions have been drawn upon for instructors: Bureau of Chemistry, Catholic University, Department of Terrestrial Magnetism, Geological Survey, Geophysical Laboratory, George Washington University, Johns Hopkins University. Johns Hopkins has been drawn upon more frequently than any other institution. The instructors exercise complete freedom in methods of handling the work.

From two to eight courses have been given per year. The lectures are usually given either in the morning before the day's work begins or in the afternoon at the close of work. It has frequently been convenient, particularly in the case of outside instructors, to have the lectures come partly or wholly in official hours, but in these cases the time was made up by the students. An exception was made last year in the case of a course in least squares, as it was necessary that the assistants in the optical division have such a training for their official work on an important undertaking. The course was consequently given half on official time both as regards the students and instructor. A similar arrangement has been made in courses this year. The tuition fees have been very moderate, averaging about \$15 per year-hour.

Relations with the local universities have been most cordial throughout. Members of the local faculties have given courses, the universities have given credit for work done at the bureau, and at various stages of development the work has been fully discussed with the university authorities. Many of the minor assistants of the bureau who have not completed an undergraduate course are taking work at the local universities, particularly at George Washington. It has been the policy of the bureau to encourage this, and hours of service are arranged to accommodate those assistants who are carrying university work.



*Laboratory courses.*—These have not been as successful as it was anticipated they would be. Only a few have been attempted. The attendance was very poor, and the percentage who dropped out entirely was very large. Men who have worked all day in a laboratory do not have as much zest for work in another laboratory as they have for theoretical work. It is difficult to get men to lay out and supervise students' work, and there is a tendency for the specialist to go too far into refinement of detail. Again, men in charge of laboratories dislike to have equipment provided for research and regular testing work used for instructional purposes, as it necessarily interferes somewhat with the regular work, involving, as it frequently does, the partial dismantling of set-ups. This last has been so important since our entry into the war that no attempt has been made to maintain laboratory courses.

Two or three small, but very successful, classes have shown the possibilities of laboratory work. The question, however, needs careful study and further trial. It is entirely possible that the solution lies in the direction of weaving the educational work more intimately into the work of the bureau itself, as, for example, in rotating the men in the different laboratories as is done by some of the large industrial organizations in their cadet engineer corps, rather than handling it as an entirely distinct educational appendage.

*New short courses.*—For the first time, a few summer courses were offered last summer. Another innovation was included in the form of a strictly undergraduate course—a review in calculus. The results of these short, intensive courses will be watched with interest, since such courses have proved to be of great importance in both military training and industrial education under war conditions. For instructors in these courses the committee was fortunate in securing professors from Leland Stanford, Pennsylvania State College, and Massachusetts Institute of Technology, who were at the bureau doing special work under temporary appointment.

*Only minor difficulties met.*—As would be expected, some difficulties and disappointing features have developed in the educational work, but none of them has been serious. There is considerable irregularity in attendance, and a much larger percentage of students drop out than is the case in universities. Much of this is inevitable, being due to the pressure of the regular official work in a bureau in which there is a large amount of overtime work done, but it seems that considerable improvement should be possible. Not as many take advantage of the courses as should when one considers how great is the opportunity offered and compares the cost with that in a university, even to the holder of an average fellowship.

*Other educational features.*—A less formal but very important phase of educational work within the bureau has been the journal meetings and seminars. The journal meeting was started in 1902, and has been held weekly, sometimes in and sometimes outside of official hours. In 1913 separate physical and chemical journal meetings were substituted for the joint meeting formerly held. The physics seminar, started in 1910, has always met outside of official hours. In several instances papers or discussions have led to investigations the results of which have been published. Since the war the physics journal meeting and the seminar have been combined, a seminar paper being given once a month. Nominally all these meetings are under the supervision of the educational committee, but it is only nominal, since the work is so organized and interrelated that no real supervision is necessary.

Of nearly equal importance from the educational point of view alone have been the weekly meetings of the scientific staff, which have been held from the very first. The purpose of these meetings has been the discussion of the technical work of the bureau, criticism of progress reports, and other important technical developments. It was the original intention of the Director that the results of investigations should be presented at these meetings for discussion and criticism before publication, but with the growth of the bureau this can now be done only in part.

The opportunity to hear, and gradually to join in the discussions in these various meetings is a most important agency in the development of the younger members of the staff, and the meetings have been decidedly successful from this as well as from other points of view.

*Effect of the war.*—At first sight one might expect that the educational work would be curtailed during the war. On the contrary it largely increased. This was also the experience of industrial companies which maintain educational organizations. In some of the largest and most important of these the work more than doubled, while the attendance at most colleges and universities very greatly decreased, until the organization of the Student Army Training Corps. The fundamental reason was doubtless the economic one, that in time of so great stress society can not afford to withdraw such large numbers of its young men and women from productive work for the several years necessary for the usual methods of education, but, on the other hand, it can not afford not to utilize the small portion of their time and efforts necessary to give them a training that will so greatly increase their powers in the pressing business of development and production.

At the beginning of the present educational year, the bureau was fortunate in being able to make arrangements with Prof. J. S. Ames, of Johns Hopkins University, to act as educational supervisor for the year, and to give two courses of lectures himself. Prof. Ames continued to have general supervision of the instruction in physics in the Students Army Training Corps at the university, at the same time acting as consulting physicist for the bureau in problems connected with airplane instruments.

As was to be expected, conditions made it advisable to extend the work into subjects more directly and intimately connected with the work of the bureau, and in some cases to give courses of a more elementary character. For example, upon the suggestion of some of the chiefs of sections a simple course in mechanical drawing is given primarily for the sake of the younger assistants who frequently have to make shop sketches and drawings for apparatus. Thus a wide range is now covered in the educational work of the bureau. Yet the more advanced theoretical work has not suffered but, on the contrary, has enjoyed a vigorous growth. In fact, under the conditions prevailing in the universities during the first half of the present academic year, it is safe to say that these courses have constituted our most thriving graduate school of physics. While the changes in the work and in the personnel of the bureau incident to the change from a war-time to a peace-time basis have had a somewhat serious effect upon the educational work, the difficulties have been by no means insurmountable.

*Results.*—All who are familiar with it agree that the educational work as a whole has been a vital factor in building up the staff and in the development of the work of the bureau. It has helped to attract and to retain able young men whose training and ability would have commanded a decidedly greater financial return in commercial work than the bureau has been able to offer them. It is significant that many of the present chiefs of sections and other men in responsible positions are the ones who were chiefly responsible for the maintenance of the educational courses in the earlier years of the work. Perhaps of equal importance has been the effect of the courses and the meetings in helping to maintain the esprit de corps.

From the point of view of the individual the work has been no less successful. It has been recognized and credited by most of our leading universities. Seventeen men have used investigations made at the bureau for their doctoral theses. Eleven of these have received credit for attendance upon the lecture courses at the bureau. The universities which have granted doctorates toward which work at the bureau has been used with the number of degrees are: Clark, 1; George Washington, 1; Harvard, 3; Johns Hopkins, 4; Michigan, 2; Minnesota, 2; Pennsylvania, 2; Princeton, 1; Yale, 1.



Fifteen of these degrees have been in physics and two in chemistry. Numerous other men have used the courses for credit toward engineering or other degrees, or in other ways, but no record has been kept of such cases. The small number who have received academic degrees is a wholly inadequate measure of the benefit derived from the work by the 300 members of the staff who have taken advantage of the opportunity.

In his report on the "Facilities for Study and Research in the Offices of the United States Government at Washington," in 1909, President Hadley made special note of the educational work of the Bureau of Standards, which was then in its early stages, referring to it as the most interesting example in the Government service. In the opinion of those who are familiar with the work, the results have amply fulfilled the promises which it then held out.

With the ever-increasing need of scientific and technical research for governmental and industrial activities, and the significantly increasing public recognition of this need, and with the still greater programs that must come as a part of reconstruction, the work of the Bureau of Standards must very largely increase. Hence it seems certain that the educational work within the bureau must take a long step in advance, probably taking a line of development intermediate between our present universities and the educational activities of the more highly organized technical industries. And with the increasing interchange, both temporary and permanent, of men between the bureau and the universities and the industries, it seems that the educational work of the bureau should be capable of development to a point where it will be of greater and greater service.

